FEATURE

Exploring the Effects of Wound Dressings and Patient Positioning on Skin Integrity in a Pediatric Burn Facility

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Although literature on the subject is scant, in practice, pressure ulcers in the pediatric burn population remain a challenge. An interdisciplinary team at an urban pediatric burn institution treats a population (average age 8 years, range 1 month to 21 years) that includes children too young or unable to articulate pressure-related pain from dressings or positioning techniques. After pressure ulcer data collection procedures were instituted, it was observed that elastic bandages, wet operating room dressings, and positioning appeared to contribute to pressure ulcer occurrence. To better understand the patient’s experience and educate staff, an informal study was conducted by an interdisciplinary committee of clinicians to assess the amount of pressure in mm Hg created on bony prominences by care procedures. Three staff members volunteered and were placed in elastic dressings and various commonly used positions for several minutes and three pressure measurements were obtained. Pressure readings of 40 and 56 mm Hg were common, causing pain and placing a person at risk for skin ulceration. The information was used to educate staff on how to maintain therapeutic efficacy without compromising skin integrity and causing pain. Lectures and hands-on demonstrations elucidated correct dressing application. The committee continues to provide education to all staff members on methods to prevent pressure ulcers from occurring in the high-risk burn patient population and ways to reduce the use of elastic wraps and improve patient positioning.

KEYWORDS: pediatric pressure ulcers, pediatric burns, pressure ulcers


An estimated one to two million Americans suffer burn injuries each year; of these, approximately 70,000 require hospitalization.1 Burns that require surgical interventions not only cause physical trauma but also have a heavy emotional toll. The scars, both physical and emotional, will impact the patient forever — it has been found for example that facial burns have a significant impact on recovery of both the child and the parents.

Medical science has made astounding advances in sepsis management and wound coverage in the burn population. These advances include artificial skin substitutes, cultured skin, advanced antibiotics, early diagnosis of infection, and medications that decrease the pain related to donor sites. The pediatric population (average age 8 years, range 1 month to 21 years) with acute burns treated at the authors’ 30-bed urban hospital are followed in the outpatient setting until they are 21 years of age and, as has been reported elsewhere, even patients with total body surface area burns of 80% and greater are living and thriving.2 The lengthy relationship between patients and the authors’ small hospital offers a unique opportunity for insight into the complications burn survivors face such as itching, keloids, and pressure ulcer formation.

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The National Pressure Ulcer Advisory Panel defines pressure ulcers as localized areas of tissue necrosis that develop when soft tissue is compressed between a bony prominence and an external surface for a prolonged period of time. Although pressure ulcers are most often seen in long-term care facilities or in the critically ill adult patient, they are not well documented. However, the incidence and prevalence of pressure ulcers in pediatric patients have been shown to be between 7% and 27% and 0.47% and 6.5%, respectively.

To assess pressure ulcer risk, facilities most frequently employ the Braden Scale, the most utilized validated pressure area risk assessment tool; however, this scale is not widely used in burn patients. A multicenter study is currently underway to explore a validated risk assessment tool for the pediatric patient that includes burn as well as spinal cord injuries. When burn patients are evaluated using the Braden Scale, they routinely fall into the highest risk category due to the nature of their injury and the need for surgical intervention (skin grafting of patients with third-degree burns). For example, at the authors’ facility, patients undergo surgery in stages on two separate days. The first stage involves excision of the burn wound down to a viable wound base (defined as tissue with an adequate blood supply). In the second stage, donor site skin is harvested and applied to the wound base. After excision and grafting, the wounds are covered with wet postoperative dressings that are irrigated every 2 hours with alternating solutions (double antibiotic and sulfamylon). During the next 5 to 7 days, patients are pharmacologically sedated to manage pain and promote immobility to improve graft take. The affected areas also are splinted or the patient is positioned to achieve optimal limb immobilization to promote graft adherence — eg, if the back requires grafting, a patient can be placed prone for 5 to 7 days. Dressings are changed on postoperative day 1 or 2 and again on postoperative day 5. After postoperative day 5, the wounds are covered with a dry dressing that is changed twice daily. All of these practices place the pediatric burn patient at greater risk for pressure ulcer development and illustrate why patients in the burn intensive care unit typically score a 1 or 2 on the Braden Scale (see Table 1).

Literature that addresses the risk and occurrence of pressure ulcers in the pediatric population is minimal. Most experts agree that instituting a pressure ulcer prevention program and continually monitoring it for effectiveness is crucial for curbing the troubling pressure ulcer trend; this is one of the proposed safety goals of the Joint Commission on Accreditation of Healthcare Organizations (JCAHO). The costs associated with the care of pressure ulcers far surpass the cost of prevention. At the authors’ institution, an interdisciplinary committee (the Under Pressure Committee) comprised of nurses, occupational/physical therapists, and physicians has been collecting data on pressure ulcer occurrences since 1999. The Committee was established as a Performance Improvement initiative to prevent pressure ulcers after it was determined that a consistent tracking method was lacking. The Committee’s mission has evolved and not only includes tracking existing pressure ulcers, but also educating staff on pressure ulcer prevention, serving as a treatment resource on pressure ulcers, and promoting further research in the area of pediatric pressure ulcers.

To fulfill this mission, any redness or skin discoloration that does not resolve on its own after the pressure source is removed for 15 minutes is tracked. The pressure source is determined by what dressing, position, or monitoring device was on the area where the pressure ulcer was found. Pressure ulcer tracking forms (see Figure 1) are completed and given to the Under Pressure Committee for follow-up and classification into the traditional staging system (see Table 2).

The committee utilized a nursing research quality assurance model to
### TABLE 1
EXAMPLES OF BRADEN RISK SCALE SCORE ASSESSMENT APPLIED TO TYPICAL PEDIATRIC BURN PATIENTS

<table>
<thead>
<tr>
<th>Sensory Perception</th>
<th>Moisture</th>
<th>Activity</th>
<th>Mobility</th>
<th>Nutrition</th>
<th>Friction and shear</th>
</tr>
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<tbody>
<tr>
<td>1. Completely limited. Patient sedated on a combination of the following medications: pancuronium bromide, morphine sulfate, midazolam hydrochloride, dexametomidine drips. Patient is ventilator dependent, intubated or has tracheostomy tube. Patient wrapped in bulky bandages that may or may not be wet. Patient may have an anoxic brain injury.</td>
<td>1. Constantly moist. Patient may have one or more of the following: wet postoperative dressings (&gt; two extremities), loose stools, wet diapers due to age, frequent bed pad changes, evaporative water loss from burn injury.</td>
<td>1. Bedfast. Patient on strict bedrest due to condition, airway management, postoperative status (immobilization of grafted areas), or extent of burns.</td>
<td>1. Completely immobile. Patient is chemically sedated on a combination of the following medications: pancuronium bromide, morphine sulfate, midazolam hydrochloride, dexametomidine drips, ketamine hydrochloride drips for airway and sepsis management. Patient is in wet postoperative dressings to large portion of body large areas of new grafting such as entire arms/legs/toro. Large donor sites (eg, entire back, buttocks). Multiple splints to several extremities or other positioning limitations such as neck hyperextension, leg abduction, arm abduction.</td>
<td>1. Very poor. Patient has inadequate nutritional status as evidenced by lab results. Transfer from another country. Patient with prolonged acute respiratory distress syndrome (ARDS)/sepsis requiring less than ideal nutritional supplements (lower protein mixtures or lower rates when patient on vasopressors due to decreased CI perfusion).</td>
<td>1. Problem. Increased movement due to pain/anxiety. Head of bed elevated at least 30 degrees at all times (tube feeding). Maximum assist with movement due to condition or pharmacologic sedation. Newly healed donors/burns/grafts (increased susceptibility to shear forces). Large-sized patient with heavy wet dressings or patient with large amount of edema (burn resuscitation/low albumin levels).</td>
</tr>
<tr>
<td>2. Very limited. Patient may be in bulky bandages that may be wet. Patient sedated with morphine sulfate, midazolam hydrochloride, dexametomidine drips.</td>
<td>2. Very moist. Patient may have one or more of the following: wet postoperative dressings (&lt; two extremities), wet diapers due to age, evaporative water loss from injury.</td>
<td>2. Chairfast. Patient allowed up to a tilt table, sit/chair chair, wagon, or ambulates with maximum assistance.</td>
<td>2. Very limited. Slightly pharmacologically sedated, two or more extremities immobilized after surgery, large donor sites, neck hyperextension, arms abducted, splints to two or more extremities.</td>
<td>2. Probably inadequate. Patient undergoing nutritional challenge for feeding tube removal, age-dependent, location of burn (eg, mouth)</td>
<td>2. Potential problem. Larger-sized patient, age-dependent, head of bed elevated most of the day.</td>
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<tr>
<td>3. Slightly limited. Young chronologically or developmentally age of patient. Pain and anxiety medications such as oxycodone and acetaminophen, acetaminophen and codeine, lorazepam, or alprazolam provided.</td>
<td>3. Occasionally moist. Wet diapers due to age, wet postoperative dressings to one small area such as an ankle.</td>
<td>3. Walks occasionally. Age-dependent mobility (eg, toddler), short distance ambulation with maximum to moderate assistance.</td>
<td>3. Slightly limited. Donor sites, immobilized graft to one to two areas, age-dependent.</td>
<td>3. Adequate. Large burn receiving adequate tube-fed supplements as guided by nutritionists, age-dependent, takes oral supplements as nutritionist recommends.</td>
<td>3. No apparent problem. Up moving age appropriately with or without assistance, near discharge, short-stay admission.</td>
</tr>
<tr>
<td>4. No impairment. Patient's age not a factor. Patient able to articulate needs. Small burn over body surface areas do not impact sensory/perception. Short-stay admission (&lt;24 hr).</td>
<td>4. Rarely moist. Wet diapers routine for age, short-stay admission (&lt;24 hr), dry postoperative dressings, no evaporative water loss from burn injury.</td>
<td>4. No limitation. Age dependent (patient too young to walk/crawl), up walking independently or may be held by a caregiver.</td>
<td>4. No limitation. Short-stay admission, small burn (no joint involvement), age-dependent.</td>
<td>4. Excellent. Small burn not involving face or mouth, patient ready to discharge, age-dependent.</td>
<td></td>
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determine through data collection and trending if the care delivered was appropriate and met pre-established outcome thresholds. The following extrinsic factors were found to contribute to pressure ulcer formation in their patient population: use of elastic bandages to secure dressings and control bleeding, use of antibiotic-irrigated operating room dressings that remain intact for at least 24 hours and are followed by dressing changes/applications for an additional 72 to 96 hours, and patient positioning that includes neck hyperextension, bilateral 90-degree abduction of arms, and prone and splinting arms. The committee sought to determine how much pressure these modalities were creating on bony prominences and how this pressure could be reliably measured to subsequently offset pressure-inducing circumstances.

**Methods**

A Tekscan™ Industrial Sensing System (Tekscan Inc, South Boston, Mass) was used to determine the amount of pressure over bony prominences created by various dressings and

<table>
<thead>
<tr>
<th>Stage I</th>
<th>Stage II</th>
<th>Stage III</th>
<th>Stage IV</th>
<th>Unstageable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persistent redness; does not blanche (light skin)</td>
<td>Shallow open ulcer with red pink wound bed, without slough or bruising, shiny or dry</td>
<td>Subcutaneous fat may be visible but bone, tendon, or muscle is not exposed; slough; may include tunneling and undermining</td>
<td>Exposed bone, tendon, or muscle; slough or eschar may be present; may have tunneling and undermining</td>
<td>Full-thickness tissue loss covered with eschar or slough so true staging cannot occur</td>
</tr>
<tr>
<td>Persistent red, blue, purple (dark skin) Usually over a bony prominence</td>
<td>Partial-thickness involvement dermis</td>
<td>Full-thickness skin loss</td>
<td>Full-thickness skin loss</td>
<td></td>
</tr>
<tr>
<td>Depth</td>
<td>Other</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not open</td>
<td>Should not be used to describe skin tears, tape burns, perineal dermatitis, maceration, excoriation</td>
<td>Watch for signs of infection, may extend down to but not through underlying fascia</td>
<td>Can extend into muscle and/or supporting structures — osteomyelitis possible, exposed bone/tendon visible or directly palpable</td>
<td></td>
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</table>

**Figure 1.** An example of a pressure ulcer tracking form.
positioning devices. This pressure distribution measurement system utilizes paper-thin, reusable sensors to measure the millimeters of mercury pressure created by various positions and dressings. A concurrent study using the same system was underway in the occupational and physical therapy departments to validate the amount of pressure exerted on scar tissue by garments.

Three healthy adult staff members volunteered to serve as test patients in this informal examination of pressure readings. The pressure exerted by the dressings and positions (elastic bandages, neck hyperextension, and legs in abduction) was measured three times with three to five minute intervals between each measurement. The readings were obtained by a physical therapist specially trained in the use of the system. The information collected was used for a real-time color display and graphic analysis.

**Results**

**Elastic wrap.** An elastic-type dressing was applied to a staff member’s arm using red rubber catheters placed too tightly over wet burn dressings. These dressings were deemed too tight based on the standardized education provided by nursing services and physical therapy on the proper application of elastic wrap. These guidelines include but are not limited to the ability to insert two fingers under the elastic bandage, the presence of brisk capillary refill distal to the elastic bandage, and the appearance of the elastic bandage not to be taut. The pressure sensor was placed under the elastic and over the burn dressing. Pressure readings were >39 mm Hg (the staff member reported immediate relief when the elastic wrap was loosened). Slightly lower pressures were measured when the arm was elevated on pillows. Elastic/wet dressings supplemented with a splint (the sensor placed under the elastic dressing and splint) yielded pressure measurements <28 mm Hg (see Figure 2).

**Neck hyperextension.** A staff member was placed in a neck hyperextension position with her occiput resting on a standard gel pad and the sensor placed between the occiput and wedge positioner. The three resultant pressure readings ranged from 35 mm Hg to 40 mm Hg. With the neck hyperextended without a protective wedge and the sensor under the occiput resting on the bed, the average interface pressure exerted was always >56 mm Hg (see Figure 3).

**Ankle splint.** All three readings of the pressure exerted by an improperly applied (too tightly fastened or foot misaligned in splint) ankle multipodous splint (sensor placed between the heel resting on the splint) exceeded 40 mm Hg. When the heel was placed on a pillow without the multipodous splint, the pressure readings ranged from 40 mm Hg to 56 mm Hg (see Figure 3).
Discussion

Extrapolating these findings to patient populations, especially pediatric burn patients, is limited because the sample size was very small and only healthy volunteers were used. However, the authors were able to determine that positioning and dressings can cause very high, sometimes painful, amounts of pressure. Tissue pressures >40 mm Hg applied for more than 2 hours are generally believed to cause pressure ulcers. Pressure readings obtained in this evaluation of commonly used dressings/positioning techniques often exceeded 56 mm Hg. Pediatric burn patients in the authors’ facility often are in these positions/dressings for 5 to 7 days. These patients frequently are not developmentally or medically able to communicate their discomfort or identify the exact location or nature of the discomfort and may be medicated for perceived pain or anxiety as exhibited by crying, fussiness, increased respiratory rate, increased heart rate, increased blood pressure, restlessness, thrashing, and or parental report, rather than provided interventions to relieve the pressure risk.

The pressure readings obtained were used to educate the staff on the importance of maintaining therapeutic efficacy without compromising the skin. The committee members utilized lectures and hands-on techniques to demonstrate the differences in a dressing applied correctly and one that is too tight and how to employ various positioning modalities. These techniques supported several adult learning styles (including the concrete experiencer, abstract conceptualizer, and the active experimenter) to facilitate a thorough learning experience for all levels of staff/learners.

Figure 4. Data collected on pressure ulcer tracking forms suggest pressure ulcer incidence and prevalence are decreasing.
The staff provided positive feedback on experiencing the pressure of the dressings and positions. Their increased empathy with patients has been reflected in their daily patient care. Policies were modified to ensure that postoperative elastic wraps were changed 2 hours after both excision and grafting surgery. The theory behind this practice is that the operative dressings are applied tightly in an effort to control bleeding. These wraps also may be applied by staff members who have a limited amount of time and do not routinely apply elastic bandages. A new protocol was developed in collaboration with all healthcare professionals involved in patient care and reflected the belief that bleeding at the surgical site should be controlled after 2 hours and that the elastic bandages should be conscientiously applied by personnel who practice this application on a daily basis. In addition, new splints also are molded within this time frame by the occupational or physical therapist to decrease patient contact with rough temporary splints formed by physicians in the operating room, further reducing opportunity for skin compromise. The overall use of elastic wrapping has been decreased before surgery and replaced by other bandage techniques such as spandex and gauze wrappings to maintain dressing integrity.

Implications for Practice
At the authors’ facility, new positioning strategies are being explored to reduce pressure as a result of neck hyperextension and limb abduction. New products have been utilized that have greatly increased both staff and patient satisfaction with these practices. Continued staff education on prevention and treatment of pressure ulcers is now mandatory and provided on a yearly basis. Research on the efficacy of various new positioning techniques and dressings will further support evidence-based nursing practice. In addition, data collected by the Under Pressure Committee utilizing the pressure ulcer tracking forms completed by nursing staff or occupational and physical therapy, suggest that pressure ulcer incidence and prevalence in the facility is decreasing (see Figure 4). Ways to reduce the use of elastic wraps and better position patients are continually explored to increase patient comfort and reduce the incidence of pressure ulcers.

Conclusion
Helping staff understand the impact of dressings and positioning on pressure ulcer development, particularly in a population that may not be able to communicate the presence or extent of pressure-inflicting stimuli, can enhance risk assessment and pressure awareness. Such awareness figures prominently in pressure ulcer prevention — a gold standard in providing optimal patient care.

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